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ABSTRACT

In a replication of an earlier study, the spellings produced by 47 learning disabled (LD) students (ages 7 to 11 years) were classified in terms of a hierarchy of spelling strategies presumed to result in conventional spelling. The developmental trends for the spelling strategies used by the LD Ss were compared to the trends previously observed for normally achieving children. Results were interpreted to show that, although the learning disabled Ss exhibited a pattern of development similar in sequence and rate of change to that of normally achieving peers, their development was significantly delayed and marked by qualitative differences in their ability to predict and evaluate their spelling product. The study replicated and extended earlier results with an analysis of errors produced by (1) a new sample of LD children, (2) a longitudinal sample, and (3) an extended set of orthographic features. The significance of these results are discussed in terms of problem solving deficiencies of LD children. (Author)

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Development of Orthographic Problem-Solving Strategies in Learning Disabled Children

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Development of Orthographic Problem-Solving Strategies in Learning Disabled Children

Spelling is one of the important tool skills underlying written communication. Skilled spellers are free to focus on clarity, logic, and substance necessary for effective writing rather than on the mechanics of translating sounds to symbols. Consequently, most spelling research has emphasized investigation of problems associated with curriculum design and instructional methods (Graham & Miller, 1979). While there has been interest in the analysis of spelling errors, this interest has derived from a concern for improving the tool value of spelling (Cahen, Craun, & Johnson, 1972).

Typically, operational definitions of spelling fail to separate spelling ability from spelling achievement (Shores & Yee, 1973). Inferences about ability are generated from analysis of qualitative data. Quantitative analysis of data provides information about achievement. When children are evaluated on the basis of number of words spelled correctly, inferences are limited to statements about spelling achievement. Correct spelling implies spelling ability but because there is no variance in correctly spelled words, measurement of spelling ability is masked. (There may be, however, variability in the ways in which words come to be spelled correctly, such as in spontaneous

self-corrections, reflective pausing or hesitation, and spelling speed.) To gain access to spelling ability, therefore, it is necessary to evaluate the qualitative information contained in the variety of ways a given word may be misspelled. In sum, number of words spelled incorrectly serves only to generate normative tables used in assessment; any qualitative information contained in the spelling errors themselves is lost.

This is not to say that there have been no attempts to systematically categorize misspellings. Three of the more frequently cited proposals for evaluating errors have been made by Boder (1971), Camp and Dolcourt (1977), and Johnson and Myklebust (1967). Boder's approach to spelling analysis represents an early attempt to use the qualitative information contained in spelling errors to derive homogeneous subgroups of dyslexic children. Her uncritical assumption was that the relative proportion of certain types of spelling errors identified specific subgroups of dyslexia (i.e., dysphonetic, dyseidetic, alexic). Classification into each of the three categories was determined by a comparison of relative performance on a word recognition and spelling dictation task. In general, children who failed to produce "phonetic" misspellings of known or unknown words were classified as dysphonetic (63%). Dyseidetics were those children who consistently produced "phonetic" misspellings even of words they were able to read (9%). A final subgroup, termed "alexics (22%)," were those children who read very poorly and produced few "phonetic" misspellings.

Three ambiguities distort interpretation of the qualitative analysis underlying Boder's work. First, Boder has confused the direction of inference in qualitative analysis. Models of cognitive processing must be constructed from consideration of qualitative variation observed in data. Boder inverted the order of logical inference by first positing, on intuitive grounds, that two central processes (i.e., auditory and visual) account for all variation in reading and spelling. By inverting the inference, the nature of the spelling problem was described in reference to the presumed psychological processes rather than to qualitative variations only observable in the empirical data.

Second, on the basis of her two-channel processing model, Boder was led to an inevitable dichotomizing of spelling errors. The range of qualitative variation in errors was reduced to either good "phonetic" equivalents or the absence of good "phonetic" equivalents. Note that "phonetic" in Boder's conceptualization means a misspelling that is decodable by a normal adult reader. The absence of such "phonetic" errors was assumed a priori to result from a central auditory processing deficit. Nothing has been explained in this analysis about what objectively constitutes either "phonetic" or non-phonetic spelling errors.

Finally, while Boder's intention may have been to obtain qualitative information about spelling errors, diagnosis of error patterns relied on quantitative rather than qualitative analysis of the empirical data.

Boder's proposal also has been questioned on empirical grounds by Holmes and Peper (1977). According to these investigators, her tripartite classification scheme fails to differentiate the error patterns of retarded readers from those of normally achieving peers. They classified errors into nine exhaustive categories and compared the percentage of errors per category made by retarded readers with those produced by a normally achieving control group. Though retarded readers made more errors in every category, the pattern of error-making in the two groups was virtually identical. That is, the percentage of errors in each category was the same for both groups.

On logical groups, error-typing systems like Boder's are inadequate because they fail to account for the possibility of qualitative change in spelling errors over time (Chomsky, 1979; Henderson & Beers, 1981; Read, 1975). This point is illustrated by Nelson (1980) who compared error patterns produced by "dyslexic" children with those made by younger, normally achieving children, matched on spelling age. As in the Holmes and Peper (1977) study, Nelson researched consecutive errors above a ceiling cut-off on a standardized test. She classified errors as "order" (i.e., missequenced), "phonetically inaccurate" (i.e., omission, addition or substitution of phoneme), or "orthographically

illegal" (i.e., sequences not allowed in English). Though dyslexic children produced more illegal and phonetically inaccurate errors than expected for their age, the percentage of errors in each category was not statistically different when comparing the dyslexic and younger, normally achieving groups.

The central point made by Holmes and Peper (1977) and Nelson (1980) was that no category of error uniquely differentiated dyslexic from normally achieving children. In fact, spelling errors in dyslexic or reading retarded children may simply reflect cognitive immaturity and not central processing deficits. Error classification systems like the one proposed by Boder are based on the assumption that certain key psychological processes are either present or absent. Qualitative inference, then, is made at the process level, relegating information contained in the actual product to "more of "or "less of" quantiative status. This view of process as static rather than dynamic is inconsistent with current conceptualizations of psychological processes in exceptional children (i.e., attentional, Krupski, 1980; linguistic, Mahoney, Crawley, & Pullis, 1980; and mnemonic, Torgesen & Kail, 1980). If our goal, therefore, is to describe the "how" rather than the "how much" associated with acquisition of spelling skills, it may be necessary to rethink how qualitative information, embedded in spelling errors, may best be used. Moreover, to generate a cognitive processing model of spelling consistent with the notion of dynamic psychological processes, consideration should be given to ontogenetic changes in qualitative information. How, then, shall we conceptualize spelling errors? A clue may

be provided by the following quotation from a letter written by an adult who had life-long difficulty in spelling.

> Dr. Fonerden: I wish to explain to you a strange mental weakness, to which I have been all my life a victim. At the age of seven or eight, I could read quite well, but shut the book and I could not spell the smallest words. My aunt who instructed me, beleeving that it was obstinancy on my part, turned me over to my grandfather, and he punished me severely gave me a collum of words to commit by a certain time; but ala, when the time had expired, I could not spell the first word, which was urn. Hour after hour and day after day was I compeled to study over this word; but let me shut the book for ten minutes and I could not spell it right, except by chance, and to my utter mortification a littled collored boy was called to spell it for me, he having lurned it from hearing it repeated to me so often. After I could see that I was looked upon as a little better than a simpleton, and years afterwards grandfater kept me at home, whilest he expended hundreds on the education of my eldest sister...How this peculiarity of my youth sticks by me still. When I went to see, I took a dictionary, with the determination never to return home until I had lurned to spell, but it was of no use. If I had kept my resolve I should never have returned. The hours of study I have wasted in endeavoring to become a good

speller would have given me a profession. For that which I read, if it excite any interest, becomes stamped upon my memory indelibly, with this single exception, that which I wonce lunr I never forget. When I left school I wrote a very good hand, but spoilt it in indeavoring so to disguise the letters, that they might pass for what they should be, instead of what they were. I had occasion very recently, to direct letter to my sister, but could not do so untill I had loocked over many books to find the name Rachal, which I could not spell. I have been puzled to distinguish between the agative too the preposition to, and between the article the and the pronoun thee. Were I to write this over from memory a great majority of the works would be spelled differently.

It were a painful task for me to attempt to innumerate the many occasions on which I have been made to suffer the most bitter mortification on account of this misfortune. But your insight into character will enable you to form some estimate of what I must have ondured. It was this that induced me to give up the business to which I was raised, and to go to sea, and has turned me aside from many things that I would have attempted,otherside. The chief difficulty that I have to content with is this; that when I write the most

firmiliar words, and then ask myself are they spelt right, some jugling friend whispers in my ear many ways of spelling them, and I become lost in a maze of doubt and conjecture. To no other than yourself would I make this humuliating confession; and only to you in the faint hope that you may suggest a remedy. If you can, all that you have done to develope my mind, and to strengthen my character, will be as noting in comparison. Yours, truly,_____

(Letter to Dr. Ponderden, Maryland Hospital for the Insane, and published in the American Journal of Insanity, 1850, p. 61-63. Emphasis added.)

This eloquent self-analysis, even with its misspellings, suggests an association between the inability to remove "doubt and conjecture" about correctness and spelling errors. Despite years of study and practice, and apparently normal intelligence, the letter's author persistently failed to improve his spelling performance. It appears that his inability to reduce uncertainty about which of a number of plausible representations was correct prevented him from ever solving "orthographic" problems.

It is possible, therefore, that the problem-solving characteristics of spelling point the direction to a new approach to error-analysis. Since "problems" are defined by the presence of initial response uncertainty, there can be little doubt that the speller, who is initially uncertain about the correct spelling of a word, faces a problem. Furthermore, problem-

solving is generally understood as the spontaneous generation of strategies and behaviors which serve to reduce response uncertainty. If spellers lack either sufficient skills or adequate strategies for solving orthographic problems, their responses will naturally fail to be correct. What is significant about this view of error-making is that spelling represents the speller's best attempt to strategically use orthographic information, and is not the result of random, illogical, or deviant psychological processes.

In a recent study, Gerber and Hall (in press) tested this hypothesis directly with carefully selected learning disabled children. They reasoned that, though spelling errors in LD children are partially the result of skill deficiencies (e.g., phonics knowledge, morphological rules, etc.), they also appeared to reflect strategic inefficiencies related to cognitive maturity. That is, when the spelling task is viewed as an occasion for problem solving, LD children appeared to show the same deficiencies in problem-solving behaviors observed in laboratory research (McKinney & Haskins, 1980). For example, they tend to make hasty, "impulsive" responses in situations of high response uncertainty. Thus, spelling attempts by LD children often appear to represent processing of superficial information (e.g., phonemic sequence) without attention to or use of other information typically available even at low levels of skill.

This analysis was partly based on the empirical demonstration that spelling errors were a function of cognitive-linguistic maturation in normally achieving children (Chomsky, 1979; Henderson & Beers, 1981; Read, 1975). Because recent investigations of exceptionality have been interpreted to show that LD children perform various laboratory tasks like younger, normally achieving children (e.g., Hallahan & Reeve, 1980), Gerber and Hall (in press) expected LD children's spelling errors to be immature, but also "strategic, logical, and orderly."

Children identified as having attentional problems and who were achieving below the level which would be predicted by their general intellectual functioning were given a dictation spelling task with low-frequency, high familiarity words. The spelling words had been previously used by Gentry (1978) in an investigation of normal spelling development between kindergarten and second grade. In addition to the low probability of these words appearing in children's reading material, each word also represented the spelling of various phonetic features (e.g., tense vowel spellings) which Read (1975) had shown to be error-inducing in immature spellers.

Misspellings were rated on a hierarchical scale paralleling the "stages" or levels of ability proposed by Gentry (1978). These "stages" or levels of ability were assumed to describe an invariant sequence of spelling attempts which reflected emerging cognitive-linguistic competence. Though the emergence of spelling ability was assumed to be continuous, five

discriminable "levels" were defined for their heuristical value. These were: (a) deviant (or preliterate -- i.e., unintelligible); (b) prephonetic (i.e., failure to represent all phonemes); (c) phonetic (i.e., phonemes represented, but by their similarity to letter names rather than rules of sound-symbol correspondence; (d) transitional (i.e., homophonic and legal orthographic combinations, but misspelled); and, (e) correct (i.e., conventional spelling). These levels were meant to suggest a process of successive approximation to conventionally accepted spelling.

The functional relationship between quality of error and chronological age was essentially the same for both LD and normally achieving samples. Moreover, LD children were observed to produce very few "deviant" spellings. These results, then, supplement those of Holmes and Peper (1977) and Nelson (1980) and provide further support for inferences made by these authors that (a) type of error does not discriminate learning disabled children from normally achieving children, and (b) error-making is developmentally sensitive. Finally, when errors contained in spelling attempts were interpreted as representing children's strategic use of linguistic information, results were consonant with laboratory-based findings linking strategy deficiencies to LD children (Torgesen & Houck, 1980).

The present research was intended to replicate and extend earlier, tentative conclusions. To increase confidence in a cognitive-developmental model of spelling behavior, replication across three dimensions was necessary. First, it was important to

show that analogous results could be obtained from similarly defined samples of LD children. Second, to demonstrate type and direction of within-child progress on the basis of cross-sectional data, longitudinal monitoring of specific children was necessary. Finally, to extend the analysis, different word types (e.g., words containing lax vowel spellings) and specific orthographic features (e.g., past tense marking) were analyzed. By obtaining parallel results using words with different morpho-phonemic and orthographic characteristics, it was possible to validate the flexible application and further elaboration of cognitive-developmental analysis of spelling attempts.

Methods

Subjects

All subjects were part of the University of Virginia Learning Disabilities Research Institute (LDRI) core sample. They were drawn from two continguous school districts in Central Virginia and were divided among five self-contained LD classrooms located in city (2 classrooms) and county (3 classrooms) elementary schools. All children met state and local eligibility criteria for special educationl services and each had been recommended by local school personnel for self-contained class placement. To be considered for the LDRI core sample, children also had to be described by the referring teacher as distractible or inattentive in regular classroom settings. The final sample contained 43 boys and 4 girls ranging in age at time of spelling assessment from 85 to 141 months. Thirty-eight (81%) of the sample children were Caucasion, 9 (19%) were Black. All children were from lower to middle income

families (based on parent occupation). Table 1 summarizes age, IQ, and achievement data for the total sample. No child had any known sensory or neurological problems and no child was currently on medication. Each of the five self-contained classrooms had one teacher and one aide. There were no more than 10 children in any one classroom and curriculum across all classrooms was based on the Direct Instruction Model (Lloyd, Epstein, & Cullinan, 1981).

For purposes of this study, the sample was divided into two groups. The first group (Group L) consisted of 15 children (14 boys, 1 girl) who had been in the LDRI classrooms for 1 or 2 years. These children had participated in a previous spelling study during the 1979/1980 academic year (Gerber & Hall, in press). The remaining 32 children were new to the LDRI classrooms and constituted a replication subsample (Group R). Age ranges for Group L and Group R were 96 to 134 months and 85 to 141 months, respectively. Table 1 summarizes psychometric information for these subgroups.

Insert Table 1 about here

Procedure

All subjects were tested individually by one of the authors. In a format resembling a typical classroom spelling test, children were required to attempt a written spelling for fourteen stimulus-words Gerber and Hall (in press). Before and after each

Table 1

Sample Characteristics - Means and Standard Deviations

Variable	Group L Continuing Subjects (N=15) Mean	S.D.	Group P 1st Year Subjects[2] (N=31) Mean	S.D.	Total Subjects[2] (N=46) Mean	S.D.
Chronological Age (in months)	120	9	113	17	115	10
WISC-R						
Verbal	90.03	11.80	95.94	10.04	94.30	10.78
Performance	94.07	12.38	98.68	11.34	97.17	11.76
Full Scale	91.80	10.05	96.87	9.78	95.22	10.05
Woodcock-Johnson Psychoeducational Battery						
Tests of Achievement						
Reading	76.60	7.01	76.13	9.27	76.28	8.52
Math	86.53	9.05	79.94	11.10	80.13	15.03
Written Language	76.53	8.31	75.39	8.48	75.76	8.35
Knowledge	86.60	10.55	88.03	13.43	87.57	12.47
Dictation Subtest	79.67	10.05	77.61	10.24	77.96	10.08
Test of Written Spelling						
Spelling Quotient	75.07	5.92	78.77	10.49	77.57	9.24

[1]Expressed as Standard Score Equivalents.

[2]One additional subject was administered the spelling assessment. His psychometric test information was not available at time of writing.

attempt, children were instructed to assess their confidence in their spelling performance. Pre-spelling assessments, or predictions, and post-spelling evaluations were indicated by crossing out one of three "faces." Each "face" represented either (a) high confidence for correct spelling, (b) uncertainty, or (c) high confidence for incorrect spelling. These faces appeared both before and after the writing space provided for spelling attempts.

Each child was told in standard instructions to try to spell every word even if the word seemed difficult. They were also told that the test was "to help us learn how children try to spell." Erasures or crossing-out of errors was not allowed, though each child was encouraged to correct errors any time and as often as they wished. Correction involved rewriting the entire word above or beside the error. After each word experimenters checked for illegible letters. Children were asked to verbally identify letters that were unclear.

Instrument

Fourteen words (high familiarity, low frequency) were used as stimulus material. Thirteen of the words were taken from a 25 word list used by Gentry (1977) to study developmental spelling patterns in normall-achieving children. The fourteenth word, flipper, was added by the authors. Gerber and Hall (in press) shortened Gentry's list to 14 words to restrict testing to a reasonable amount of time for LD children. The 13 words selected

from the Gentry list were: united, hiked, eighty, elevator, closed, toad, eagle, peeked, human, type, dressing, traded, and swimming. These words, as well as the others in the Gentry word list, were selected because they contained examples of various phonetic features and spellings which Read (1975) identified as being developmentally sensitive. More importantly, certain phonetic features require more than "blind rule following" (Brown, 1978) to be correctly spelled. Tense words, for example, require orthographic marking to signal their correct pronunciation. Spellers must make decisions about orthography by using other than simple sound-symbol transformation rules. For other orthographic problems, such as marking a verb to indicate past tense, sound structure alone provides insufficient and misleading information (e.g., traded, closed, hiked). Spellers must use a syntactic function-symbol transformation rule to spell such words correctly. For these reasons, spelling exemplars used in the present study were thought to provide an opportunity to study cognitive functioning and not just rule application.

The final word list, then, contained exemplar spellings for five tense vowels, two lax vowels (i.e., "short" e and i), and three phonetic forms for the past tense marker "ed" (i.e., /ID/, /t/, /d/). In addition, Gentry's words were selected to reduce the probability that they would be overlearned by his subjects. Since Gerber and Hall (in press) were testing older, non-normally achieving children, they examined additional indices of word familiarity and word frequency. Hence, the 14 words

represented less than 1% of non-repeated words commonly written by children (Hillerich, 1978). Correct meanings for these words, however, known by 73% to 94% of all fourth graders (Dale & O'Rourke, 1976).

Measures

Three measures of spelling performance were collected from each protocol: (1) a quality rating for each spelling attempt, (2) children's pre- and post-spelling assessments, and (3) self-correction rate. Though measurement was not complex, some conceptual and technical clarifications are in order.

Quality rating. Spellings were globally rated on a five-point scale derived from a variety of techniques developed by Henderson and his colleagues (Henderson & Beers, 1981). Ratings, their descriptive labels, and some examples are as follows:

5 = Correct spelling (e.g., eighty, eagle, closed)

4 = Transitional spelling (e.g., aetey, eequl, cloesed)

3 = Phonetic spelling (e.g., ate, egl, closd)

2 = Prephonetic spelling (e.g., ae, gl, cvd)

1 = Preliterate spelling (e.g., BT, rwf, gnono)

Both Read (1975) and Henderson and Beers (1981) have presented theoretical justification and empirical evidence that misspellings represent part of a developmental continuum in which children produce qualitatively better approximations to "correct" orthography. Consequently, Gerber and Hall (in press) and the present study treat ratings as ordinal and not simply categorical.

It is not justifiable on either theoretical or empirical grounds to treat the quality rating variable as having equal intervals. Consequently, non-parametric and simple descriptive statistics were used in data analysis. Evidence supporting the use and reliability of this measure comes from comparison of qualitative spelling ratings and standardized spelling achievement scores for the LD longitudinal sample. If the quality rating represents a hierarchial continuum of spelling ability and we assume that spelling achievement is a function of spelling ability, then rank ordering of subjects on the two variables should be close to identical. Prior to collecting experimental data for this study, the Test of Written Spelling (Larsen & Hammill, 1976) was administered to all sample children. For Group L children, the Spearman rho rank-order correlation between quality ratings and grade equivalent scores was .88.

Rating criteria reflect the underlying assumption that strategic development and linguistic maturity influence spelling production independent of idiosyncratic knowledge.

1. Transitional spellings are legal and do not contain impossible orthographic sequences. They account for every phoneme with some conventional graphemic alternative. Finally, they show evidence of knowledge about orthographic marking (e.g., vowel pairing, silent e, use of "ed" for past tense).

2. Phonetic spellings represent every phoneme but, tense vowels and certain syllables are represented by single letters whose articulation position approximates that of the stimulus-phoneme (e.g., egl for eagle, humn for human, and luvtr for elevator). Many studies of error classification use the term "phonetic" to describe spellings which the adult reader can decode or pronounce like the intended word. The present scheme, following Read's (1971, 1975) analysis, would classify most such spellings as "transitional." Read (1971) points out that adults do not recognize phonetic spellings as systematic and intentional because adults have learned (and cannot "unlearn") a different system of phonetic and orthographic relations.
3. Prephonetic spellings fail to represent one or more phonemes in any way. Children who produce this type of spelling may have immature segmentation abilities (e.g., Liberman, Liberman, Mattingly, & Shankweiler, 1980). It is common to observe that children who produce this type of spelling leave spaces while they write. They may verbally acknowledge that they know that letters are missing but they are not sure which are the missing letters. The spellings may consist of a single initial consonant (e.g., t for traded), several letters recognizably related to either phonetic, transitional, or correct spellings,

(e.g., sim for swimming), or more typically, well developed spellings with or without "spaces" to represent dropped phoneme/grapheme sequences (e.g., dossing for dressing, or cosd for closed).

4. Preliterate spellings suggest a limited understanding of the concept that written words are composed of alphabet strings. They fail to evidence only predictable phoneme-grapheme relationships and/or fail to exclude idiosyncratic symbols and numerals (e.g., 8T for eighty). Simple reversals, inversions, or transpositions are not considered preliterate. Consequently, "qeekt" is accepted as a malformed, but not uninformed, phonetic spelling of "peaked." This type of spelling was labeled "deviant" by Gentry (1978) and Gerber and Hall (in press), but both acknowledged that it was the subjective unintelligibility of the spelling and not explicit evidence of "deviant" cognition that was salient. Theory building benefits, we feel, by avoiding the connotations of the term "deviant," unless convergent evidence of cognitive deviance can be presented.

Self-assessment ratings. Self-assessment ratings of performance confidence were designed to provide a gross measure of metacognitive (or metalinguistic) awareness, much in the same fashion that Levin, Yussen, DeRose, and Pressley (1977) asked children to estimate their performance on memory tasks.

Metacognitive variables have been implicated as mediators of task performance, particularly in younger and exceptional children (Loper, 1980; Hall, 1980).

Though "meta" terminology has only recently appeared in the literature, similar concepts with regard to spelling performance are quite old. McFarland (1916), Lull (1916), and Tidyman (1924) asked pupils to rate their confidence after they had spelled test words in an attempt to relate spelling "consciousness" to performance. Unfortunately, it appears that this line of investigation has been dormant until recently (Gerber & Hall, in press; Valmont, 1972).

The present study measured and compared the percentage of ratings in the three categories by word, by child, and by group (i.e., previous LD sample vs. present subjects). Previous work with this variable (Gerber & Hall, in press) has shown that ability to predict accurately one's spelling performance is a function of maturation and spelling experience. LD children, as a group, predicted correct spelling proportionately less than same-age normally achieving peers, but were wildly inaccurate when their predictions were compared with actual percentages of correct spellings. Moreover, their post-spelling confidence was unreasonably high, suggesting that they were unable to both predict and evaluate their relative knowledge about orthography.

Spontaneous self-correction. A final measure -- rate of spontaneous self-correction -- replicates measurement procedures used in previous work (Gerber & Hall, in press). Self-correction was encouraged at the beginning of the testing session, but children were not prompted to correct during testing other than by

whatever natural prompt was associated with the instruction to assess their work. Without erasures and cross-outs, corrections, as a proportion of words attempted, could be objectively calculated. This variable was thought to be indicative of the relationship between metacognition (i.e., self-assessment) and spelling quality (i.e., rated spelling).

Current validity of 14-item list. Given the assumption that measures of spelling ability predict measures of spelling achievement, it follows that the qualitative, hierarchical scoring procedure used to evaluate spelling errors should predict spelling achievement. If the ability to spell words correctly evolves along a continuum of successive approximations, then qualitatively better spellings should reflect a general spelling maturity and thus greater spelling achievement. If, on the other hand, there is insufficient range in the 14 items word list (floor or ceiling problems) or if the words on the list are too parochial or reflect knowledge of specific, idiosyncratic spellings than the relationship between performance on the word list and that on a standardized measure of achievement should be attenuated.

To test these assumptions, the Test of Written Spelling (TWS) (Larsen & Hammill, 1976) was administered to all sample children (see Table 1). Because the qualitative index used in evaluating spelling errors was ordinal, a Spearman rho statistic for rank order correlations was computed to examine the relationship between qualitative and quantitative measures of

spelling. The correlation coefficient was .80. We would conclude, therefore, that qualitative performance on the 14 item word list reflects spelling maturity and is positively related to level of spelling achievement.

Interscorer Agreement

Three scorers, the two authors and an elementary school teacher, independently rated the 658 spellings produced by Group L and Group R children. Tense vowel (TV), lax vowel (LV), and past tense marker (PTM) exemplars were rated separately. Scoring reliability was calculated as the percentage of agreements divided by the total number of spellings. Reliability percentages were compared for each pair of scorers and for each type of exemplar. The results were as follows:

	TV	LV	PTM
Scorer 1 x Scorer 2 =	83.5%	85.8%	83.8%
Scorer 2 x Scorer 3 =	85.1%	88.3%	89.4%
Scorer 1 x Scorer 3 =	81.6%	85.1%	83.2%

Every item for which there was scorer disagreement was re-examined. Systematic scoring errors due to misinterpretation of scoring rules or rater "drift" were completely resolved prior to analysis of the data.

Questions

This study was designed to address the following questions:

1. Are the age-spelling quality relationships reported by Gerber and Hall (in press) for LD students generalizable to an independent, similarly defined LD group?

2. Do self-assessment ratings and rates of self -correction differ for independent, but similarly defined LD groups?
3. When followed longitudinally, will Ld children's spellings show evidence of qualitative improvement as predicted by cross-sectional data?
4. Will the age-quality relationships observed in spellings of words containing lax vowels or spellings of past tense markers parallel those obtained for words containing tense vowels?

Results

Age and Spelling Quality

In previous work (i.e., Gerber & Hall, in press), a functional relationship between chronological age and spelling quality ratings was demonstrated via graphical comparison of mean ratings by age. A more formal test of this relationship was conducted in the present study. Rank order correlation coefficients (Spearman rho) for age and spelling quality measures were computed for 39 LD students tested previously and for 32 students (i.e., Group R) participating in the present study. For measures obtained in the previous study, the rank order correlation coefficient equaled .54 ($p < .05$); the correlation coefficient for age and spelling quality in the present study was .72 ($p < .05$).

These statistically significant correlation coefficients support an interpretation that spelling quality is a monotonic increasing function of age. This replicates the earlier finding of an age/quality relationship. However, without a comparison of central tendency estimates in the two sets of ratings it is impossible to infer that the distributions of ratings from the two samples are the same.

To determine if the two samples were distributed identically, a median test for comparing independent samples (Hays, 1973) was performed. The observed test statistic ($\chi^2 = 3.43$, df = 1) did not exceed the critical value $\alpha = .05$, thus, there was a failure to reject the null hypothesis. This implies that the distribution of quality ratings for the two groups of LD students did not differ. It should be noted that both LD samples were selected according to the same criteria and that their chronological age distributions were similar (i.e., first sample: $\bar{X}$ = 116 months, σ = 13, range = 77-144; replication sample: $\bar{X}$ = 113 months, σ = 17, range = 85-141). A reasonable interpetation of these results, then, is that spelling quality ratings for the two samples were identically distributed. In sum, it would appear that the relationship between spelling quality and age, characteristic of the first year sample, was also characteristic of the replication sample.

Self-Assessment and Self-Correction

Self-assessment. Table 2 summarizes percentage of words for which LD students rated their confidence (both before and after their spelling attempts) as high-correct, uncertain, or high-incorrect. Comparable values for LD students from the Gerber and Hall study are also presented.

Insert Table 2 about here

As can be seen from Table 2, in each group there is a small reduction in percentage of spellings rated as "uncertain" from pre to post-assessment. In addition, there were concomitant increases in each of the groups in high confidence for correct spellings from pre- to post-assessment. While these changes were small, they were consistent and thus may reflect the fact that confidence in a spelling being correct increases once it has been written.

In part, these small percentage changes mask the accuracy of the student's self-assessment. Table 3 summarizes confidence assessments for words spelled either correctly or incorrectly by LD students. Even though there were relatively few correct spellings (see Table 4) produced by the LD students, they were quite accurate in recognizing when their spellings were correct. They were not as accurate in their detection of incorrect spellings. Nevertheless, if "uncertain" and "high-incorrect" ratings are taken to represent "doubt" that a spelling was correct, then it can be seen from Table 3 that LD students were not insensitive to their own incorrect spellings. Approximately

two-thirds of incorrect spellings were rated as doubtful (i.e., uncertain high-incorrect ratings) by the LD students.

Insert Table 3 about here

In summary, pre- and post-confidence assessments were very similar for both the present LD sample and the sample previously studied. Moreover, earlier findings were extended to show that LD students like their normally achieving peers (Gerber & Hall, in press) were fairly accurate in their ability to identify correct spellings and not incapable of identifying spellings which were incorrect.

Self-correction. Table 4 summarizes information regarding spontaneous self-correction for the LD sample. For all groups, the percentage of total number of word attempts that contained spontaneous self-correction was small. On the average, children in Group R self-corrected about 2.2 words per list compared to 1.7 words per list for the first year sample. Average number of words self-corrected per list for Group L and for the second year sample was 3.1 and 2.5, respectively. These self-correction rates are similar to those reported by Gerber and Hall (in press) for the normally achieving elementary age sample (1.7 words per list).

Insert Tables 4 and 5 about here

Table 2

Percentages of Pre and Post Spelling Attempt Ratings
Scored as High-Correct, Uncertain, or High-Incorrect
by Learning Disabled Sample Students

Variable	Group L[1] Continuing Subjects (N=15) Pre%	Post%	Group R[2] New Subjects (Year 2) (N=31) Pre%	Post%	Group O[3] New Subject (Year 1) (N=39) Pre%	Post%
High-Correct (+)	39	40	39	44	47	52
Uncertain (?)	43	42	41	34	31	25
High-Incorrect (-)	18	18	23	22	22	23

[1]Longitudinal Sample - Subjects in this group were assessed during year 1 and year 2. Percentages reported in this table reflect the year 2 assessment only.

[2]Replication Sample - Subjects in this group were new to the year 2 sample.

[3]Original Sample - Subjects in this group were the total year 1 sample.

Table 3

Pre and Post Confidence Assessments for Words Spelled Correctly or Incorrectly by Year 2 Sample Learning Disabled Students (N=46)

Variable	Pre Assessment		Post Assessment	
	Correct%	Incorrect%	Correct%	Incorrect%
High-Correct (+)	70	35	75	39
Uncertain (?)	28	43	22	39
High-Incorrect (-)	2	21	2	23

Table 4

Percentage of Spellings with Spontaneous Self-corrections and Actual Percentage of Words Spelled Correctly for LD Students

Variable	Group R(%) (n=32)	Group L(%) (n=15)	Total Sample(%) (n=47)	Year 1 Sample (%)* (N=39)
Total attempts[1]	16	23	18	12
Total corrected[2]	1	2	1	--
Corrected attempts[3]	4	10	7	--
Correct Words[4]	12	14	13	17

*From Gerber and Hall (in press)

[1]Percentage of total number of word attempts that contained spontaneous self-corrections.

[2]Percentage of total number of word attempts that were spelled correctly following a spontaneous self-correction.

[3]Percentage of spontaneous self-correction attempts that resulted in a correct spelling.

[4]Percentage of total number of word attempts that were spelled correctly.

Table 5

Rank Order Correlation Coefficients* for

Tense Vowel, Lax Vowel, and Past Tense Marker

Spellings and Chronological Age for LD Students (N=32)

	Tense Vowel	Lax Vowel	Past Tense Marker
Chronological age	.72	.78	.53
Tense vowel		.80	.91
Lax vowel			.70

*all Spearman rho coefficients are statistically significant with $p<.05$.

Differences among groups for spontaneous self-corrections are small and may only reflect random sample fluctuations. Nevertheless, the slightly higher self-correction rate found in the longitudinal sample (Group L) may be due to factors of age and amount of time spent in the experimental classroom.

As reported in Table 5, there is a strong, positive relationship between age and ratings of spelling quality. Consistent with this result is the finding that there were small but positive changes in the rated quality of spelling attempts produced by Group L students from pre- to post-assessment.

Taken together, the findings from Tables 3 and 4 are more striking for their similarities than for their differences. Few words were correctly spelled by any LD sample, and few self-corrections were attempted even though LD students rated nearly 2/3 of their incorrect spelling attempts as "uncertain" or "high-incorrect." In contrast, normally achieving students produced self-corrections at about the same rate and were about as accurate in assessing the uncertainty of their spelling product. They spelled approximately 77% of the words on the list correctly, however. For normally achieving students, self-correction generally resulted in a correct spelling. For LD students correct spellings resulting from self-corrections were neglible. Apparently, LD students, when faced with difficult but solvable spelling problems, fail to profitably use information that they may already possess to improve the quality of their spelling attempts. This appears to be the case even when self-assessment

of their product leads them to believe that their spelling is incorrect. This suggests a relationship between the LD student's ability to recognize uncertainty and their ability to act in accordance with that recognition. A child may be uncertain about a spelling but, fail to respond further because of an inability to identify the source of that uncertainty.

Longitudinal Followup

To test whether within child changes over time were consistent with changes predicted from analysis of cross-sectional data, Bowker's test of the homogeneity of proportions for qualitative variables in correlated samples (Marascuilo & McSweeny, 1977) was used to analyze Group L spelling quality ratings from year 1 to year 2. The null hypothesis being tested was that all pairs of symmetric probabilities were equal. Table 6 helps to illustrate the question under investigation. Under the conditions of the

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Insert Table 6 about here

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null hypothesis, it would be expected that (a) ratings at time 1 were the same as ratings at time 2 (represented by diagonal elements), and/or (b) any rating change that occurs from time 1 to time 2 should be distributed such that increases and decreases in ratings are equiprobable (represented by off-diagnosed elements). As can be seen in Table 6, off diagonal elements favor increases over decreases in ratings. The observed test statistics ($\chi^2 = 30.96$, $df = \binom{5}{2} = 10$) exceeded the critical value at $\alpha = .05$. Therefore, the null hypothesis was rejected.

Two inferences can be made from this analysis. First, changes in ratings from time 1 to time 2 primarily increased. For 88% of all spellings, ratings remained the same or increased at time 2. Second, rating changes tended to be incremental. That is, 73% of all rating increases and 100% of all rating decreases (15 words) were by only one rank. Given that there were only five instructional months between assessments, it would be expected that qualitative changes would increment gradually rather than rapidly. If spelling changes only reflected idiosyncratic within-child variability or special word knowledge, large random changes and dramatic increases in number of correct spellings would be predicted. However, only 9% of all increased ratings were for qualitative changes of more than two ranks and at time 2 there were only eight (5%) more correct spellings that at time 1. In summary, the observed pattern of within-child changes was consistent with the cross-sectional trends reported by Gerber and Hall (in press).

Additional Phonetic Features

To determine whether the observed age/spelling quality relationship was specific to spelling of words with tense vowels, the qualitative rating system was applied to words containing only lax vowels. The Spearman rho correlation coefficient relating age and spelling quality ratings for lax vowels was .78. Moreover, when LD children in Group R were ranked on the basis of quality ratings for both tense and lax vowel spellings, the rank order correlation coefficient was .80 (see Table 5). Thus, the age/quality relationship observed for lax vowel spellings

Table 6

Changes in Proportionality for Spelling Ratings

From Time 1 to Time 2 for 150 Spellings by LD Students[1]

	Time 1					
Variable	Preliterate	Prephonetic	Phonetic	Transitional	Correct	Tota
Time 2						
Preliterate	0	0	0	0	0	0
Prephonetic	4	31	9	0	0	44
Phonetic	3	28	29	6	0	66
Transitional	1	3	12	10	3	29
Correct	0	4	5	2	0	11
Total	8	66	55	18	3	150

[1]Compares 10 words with tense vowels spelled by each of the Group L subjects.

does not differ from that observed for tense vowel spellings.

To better understand the nature of the relationship between age and spelling quality, it was necessary to examine a well-defined orthographic feature, the correct spelling of which, is not predictable from what the speller hears. The distinction here is between global analysis of spelling quality and analysis tied to specific word features. That is, evidence for a developmental continuum of spelling skill should be present regardless of the unit of analysis. This should be the case as long as the feature to be rated develops slowly enough so that change can be measured.

For example, the past tense marker (-ed) cannot be spelled correctly unless the speller recognizes that (a) the word in context is orthographically marked to show past tense, and (b) the marker is spelled the same despite variations in its pronunciation (e.g., traded, closed, hiked). If, as has been hypothesized, immature spellers attempt to directly encode phonemic strings, spellings of the past tense marker should be observed to change from sound-symbol translations to spellings which reflect the strategic use of syntactic knowledge.

While a relationship is expected between age and spelling quality ratings, there is a potential range restriction problem in the present data. By definition, spellings are rated as transitional only if the past tense

marker has been correctly spelled. Consequently, no distinct rating of the past tense marker viewed in isolation differentiates a transitional from a correct spelling. It would be predicted, therefore, that the relationship between past tense marker spelling quality and age would be moderate. This prediction was confirmed; the rank order correlation coefficient was .53 (see Table 5).

Finally, there were strong, positive, rank order correlations between rated spellings of words with tense or lax vowels with spellings of the past tense marker (i.e., .91 and .70, respectively). The high correlation for words with tense vowels may represent an artifact of the word list. Four of the ten words with tense vowels rated in both earlier (Gerber & Hall, in press) and present analyses also contained a past tense marker. By definition, the quality of spelling for these words was in part determined by the correctness of the spelling of the marker. In contrast, the ratings of spellings for words with lax vowels were independent of ratings for spellings of the marker.

In summary, ratings of spellings containing features other than tense vowels corroborate the relationship between spelling quality and chronological age. These results are consistent with the notion that spelling errors reveal qualitative improvements over time.

Discussion

The present study was conducted to replicate and to extend earlier findings reported by Gerber and Hall (in press). Results can be summarized as follows:

1. Spelling quality ratings for the LD sample were a monotonically increasing function of chronological age.

2. Within-child longitudinal changes in spelling quality were in the direction predicted by cross-sectional data.

3. Qualitative changes in spelling attempts were discrete and incremental along a hierarchical scale rather than discontinuous as would be expected if they were idiosyncratic to learners or to words.

4. Qualitative ratings of words with tense or lax vowels were highly correlated with chronological age.

5. Qualitative ratings for spellings of the past tense marker "-ed" were moderately correlated with chronological age.

6. Learning disabled students were appropriately confident of correct spellings and were fairly accurate in detecting their misspellings.

7. Despite awareness of errors, spontaneous self-corrections resulted in very few correct spellings for the LD students in this sample.

These analyses illustrate the degree to which spelling may be influenced by application of orthographic rules over and above knowledge of sound-symbol correspondence. Thus, they may reveal the degree to which spelling is influenced by

by general strategic abilities.

Instructional Implications

Spelling is a skilled behavior and, therefore, a behavior susceptible to instructional interventions. Teachers must be clear about their purposes if they wish to plan interventions based on an analysis of spelling errors. When specific words must be learned, they may be taught directly. In this circumstance, the teachers would be less interested in the quality of the spelling attempt than in the fact that the spelling is incorrect. However, spelling errors may contain additional important information for the teacher.

To illustrate this point, consider problem solving in the context of a rule-governed game. Errors during game playing can result from either (a) lack of knowledge about the rules, (b) failure to use rule knowledge to one's advantage (i.e., strategically), or (c) both knowledge and strategy limitations. Once all of the rules are learned, playing effectiveness is determined by how efficiently rules are manipulated by the player.

Spelling and many other academic tasks have problem solving properties similar to those described in the game analogy. For example, mathematical problems (e.g., "word" problems) assume that basic operations (i.e., rules) are well understood. The students "problem" is to evolve a strategy for reducing given information to an operational form that can be readily solved. At a higher level of abstraction, composition writing follows the same general schema. Once rules

of spelling, sentence mechanics, handwriting, and conventional organizational structure (i.e., beginning, middle, end) are understood, the "problem" confronted by the student is to effectively (i.e., strategically) make use of these rules to express a set of ideas in a coherent and logical fashion.

Spelling appears to possess these problem-solving properties. Spellers must become facile with using various categories of information (e.g., phonological, morphological, syntactical, semantic) to "solve" orthographic problems. Unfortunately, traditional approaches to spelling instruction tend to emphasize only the most utilitarian categories of information (e.g., sound-symbol correspondence and high frequency spelling patterns). Students are not taught to make use of other information about orthography which they may already possess. For example, they may be aware of (a) what phonetic features are error prone (e.g., tense vowel spellings), (b) what probability is associated with spellings using different vowel pairs, (c) what are the effects of shifts in stress on pronunciation and spelling, and (d) what semantical considerations constrain orthography. Teachers also fail to teach students about the usefulness of analogical reasoning, word recognition (i.e., proofreading at a whole-word level), and the use of uncertainty to generate alternative spellings and self-corrections. Finally, it should be noted that very basic skills often have not been assessed or taught when remedial instruction is planned. For example, prephonetic spellings reflect a failure to finely segment words into their "correct" phonemic components.

Phonetic misspellings are associated with confusing the assigned phonic value of letters with the articulation positions used in pronouncing letter names. Both of these inappropriate strategies may prove amenable to a direct remedial intervention that is mre efficient than word-by-word correction procedures.

In summary, different instructional objectives will result from different inferences about spelling errors. Figure 1, for example, represents types of instructional objectives which might be targeted from progressively broader inferences about misspellings. As can be seen from Figure 1, highly focal interventions (e.g., correcting single misspelled words) have relatively high probability for producing short-term achievement gains (i.e., at least one new correct spelling), but relatively low probability for producing generalization. Conversely, interventions aimed at more strategic skills (e.g., analogical comparison to known words to stimulate generation of spelling alternatives) have relatively high probability for producing generalization, but low probability for producing short-term achievement gains. (Note that achievement is defined here as any increment in the number of words spelled correctly. Generalization means an increase in the number of words to which newly acquired orthographic information can be applied.) Therefore, the major implication of the present study is that teachers may increase the ability of students to solve orthographic problems if efforts are made to teach broadly applicable strategies in addition to providing corrective feedback for single-word misspellings.

Figure 1- Example: student writes RAT for RAKED

Inference 1: Word is misspelled.

Instructional objective: Reteach word.

p(achievement) is high

p(generalization) is low

Inference 2: Word pattern "-ake" has not been learned

Instructional objective: Teach exemplars of this pattern (e.g., bake, cake, fake)

p(achievement) is high

p(generalization) is moderate

Inference 3: Correct segmentation of phoneme /k/ when followed by past tense (-ed) has not been learned

Instructional objective: Teach correct segmentation and transcription of /k/ - k for exemplars such as hiked, baked, choked

p(achievement) is low

p(generalization) is high

Inference 4: Rules for tense vowel and past tense orthographic marking have not been learned

Instructional objective: Teach "silent e" rule; teach meaning of past tense; teach "-ed" marking for past tense; teach conventional spelling of CVCe + ed (e.g., hike/hiked; bake/baked)

p(achievement) is moderate

p(generalization) is high

Inference 5: Word is misspelled despite evidence student can spell homophones and homographs

Instructional objective: Teach analogical reasoning and generation of alternatives strategy

p(achievement) is low

p(generalization) is high

Research Implications

In addition to being a tool skill susceptible to instruction, spelling may provide a useful and applied research model of cognitive processing (e.g., see Frith, 1980). Though the information spellers manipulate to solve orthographic problems may be specific to spelling tasks, it is reasonable to suppose that basic cognitive processes common to many problem-solving situations underlie spelling performance. From this perspective, the conventional wisdom that spelling is learned by rote memorization serves to label rather than to dispel our ignorance about mnemonic activity and its flexibility, power, and strategic character. Nor is it totally satisfying to accept the view that spelling performance results from directly taught "rules." Whatever "rules" are applied by spellers facing "doubt and conjecture" about a number of plausible spellings must be highly abstract. Simon and Simon (1973), for example, pointed out that average fourth grade students can often spell better than a computer programmed with a sound-to-spelling algorithm consisting of hundreds of specific phoneme-grapheme translation rules.

This paper has argued that spelling and error-making should be reconsidered in light of laboratory-based models of cognitive process variables, such as decision speed, mnemonic strategy, selective attention, and executive function. Empirical evidence suggests an interpretation that information processing ability depends on its developmentally sensitive components. Likewise, the spelling process may be better conceived in terms of the same componential determinants. When analyzed in this way, spelling

performance (correct or incorrect) is the result of transacting task, person, and strategy variables similar to those proposed in abstract problem-solving models. Consequently, researchers may find that applied spelling tasks are rich sources of convergent and confirmatory data.

Of current interest to developmental psychology is the question of how children's ability to monitor and manage their own cognitive activity changes over time (Flavell, 1979). A parallel interest in LD children's apparent failure to efficiently generate appropriate prolem-solving strategies has resulted in a rapidly proliferating research literature (e.g., Lloyd, Hallahan, & Kauffman, 1980). By studying task, person, and strategy variables as they interact in LD students during spelling tasks, we have an opportunity to learn more about basic components of cognitive processes as they operate in naturally occurring problem-solving situations.

The present study has laid a foundation for asking both basic and applied questions about a spelling model of problem-solving. Many questions remained to be addressed. What is the relationship between acknowledged uncertainty and ability to use effectively whatever information might reduce that uncertainty? How does spontaneous self-correction and the quality of attempts at self-correction relate to mnemonic activity, control of attention, or decision speed? Are difficulties in formulating efficient problem-solving strategies related to an individual's susceptibility to instruction? How does effectiveness of instruction interact with level of development? Finally, what are the implications for our

understanding of learning disabilities when an attempt is made to answer these questions?

For the present, it would be useful to examine how word recognition ability interacts with spelling ability in LD students. Their demonstrated sensitivity to misspelling and their failure to gain significantly from self-correction attempts suggests possible metacognitive or executive function deficiencies. It would be interesting to know if, when asked directly, LD students could articulate reasons for accepting or rejecting orthographic choices.

Second, many of the measurement issues arising from this study should continue to be investigated. It would be particularly important to determine whether spelling quality ratings can be made more sensitive to individual differences along a continuum of abilities. For example, rating the representation of each phoneme might permit better discrimination among spellers than the relatively global ratings used in the present research. More sensitive measurement would also allow researchers to reduce the annoying heterogeneity of most LD samples. Furthermore, there is a need to establish more thoroughly the predictive validity of a hierarchical rating system such as we have proposed. Finally, it would be helpful to demonstrate the utility of quality measures of spelling errors to supplement achievement measures derived from one or more standardized spelling tests.

Third, training studies using the "instructional model" of Belmont and Butterfield (1977) should attempt to investigate the susceptibility of self-assessment, self-correction, and more global "proofreading" behaviors to direct instruction.

If LD students lack an organized plan for solving orthographic problems, it may be possible to teach them to use appropriate strategies. Learning disabled students may fail to accurately assess their own orthography or to know what type of information they lack or may require. In this case, it might also be possible to instruct them in routines that will lead to more accurate and explicit self-assessment and problem-solving behavior.

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